COLOR STABILITY OF NATURAL COLORANT ON BLUE PEA FLOWERS

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ABSTRACT

The use of natural colorants is highly increasing in the food industry due to strong consumer demand for more natural products. On the other hand, synthetic colorant give harms to consumers that may affect health because of the unsuitable chemicals contained. Color stability of certain product is important to maintain its appearance that differs in many aspects. This study aimed at determining the color stability of blue pea flower based on the storage days, the use of different solvents and its concentrations. The blue pea flower was kept soaked at room temperature with each methanol and ethanol as solvents and an addition of maltodextrin as stabilizer every day for 7 days. Solutions of colors and solvents, methanol and ethanol were then heated at boiling point of each solvent, 64.7°C and 78.4°C, respectively. The samples obtained was analyzed and tested by using a programmed spectrophotometer, giving results of its qualities and changes of the color. Based on the results, methanol with concentration of 20 percent and storage days at the 7^{th} day is at its best in maintaining the color stability. The value of L and a* are quite consistent through the days while b* value undergo little changes that shows its stability compared to other parameters. Thus, the color stability of the blue pea flower based on data collected is suitable to be a natural colorant with a high stability to replace synthetic colorant.

ABSTRAK

Kestabilan warna bagi sesetengah produk adalah penting untuk mengekalkan pandangan yang berbeza dalam pelbagai aspek. Penelitian ini bertujuan untuk menentukan kestabilan warna biru bunga telang berdasarkan hari simpanan, penggunaan pelarut dengan kepekatan yang berbeza. Bunga telang direndam pada suhu bilik dengan metanol dan etanol sebagai pelarut dan penambahan maltodekstrin sebagai penstabil setiap hari selama 7 hari. Larutan kedua-dua warna dan pelarut kemudian dipanaskan pada takat lebur masing-masing. Sampel dianalisis dan diuji, dan keputusan bagi kualiti dan perubahan warna diperolehi. Berdasarkan keputusan, metanol dengan kepekatan 20 peratus dan hari simpanan pada hari ke-7 adalah parameter yang terbaik dalam menjamin kestabilan warna. Nilai L* dan a* cukup konsisten sepanjang hari simpanan manakala nilai b* mengalami sedikit perubahan yang mempengaruhi kestabilannya. Dengan demikian, kestabilan warna biru bunga telang berdasarkan data yang dikumpul adalah sesuai menjadi pewarna semulajadi dengan kestabilan yang tinggi untuk menggantikan pewarna sintetik.

TABLE OF CONTENT

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBRIEVIATION/TERMINOLOGY/SYMBOLS

mm – millimeter

nm – nanometer

L* - lightness

a* - green to red

b* - blue to yellow

cm – centimeter

v/v – volume per volume

°C – Degree Celcius

ml – milliliter

% - percentage

LIST OF APPENDICES

CHAPTER 1

INTRODUCTION

1.1 Background of Study

Colorants are widely used for variety of applications. Some are used in processes of manufacturing colored products. Colorants are also being used as additives in foods, drugs, and cosmetics. As for food colorant, it can be categorized into two kinds of colorant which are natural colorant and synthetic colorant. Natural colorant is the color that occurs naturally. It can be discovered mostly from the fruits and vegetables. Natural colorant can be classified into several types such as chlorophylls, carotenoids and anthocyanins. Chlorophylls are green pigment that appears mostly in vegetables and green fruits. Carotenoids are the pigments which distribute the color of red to orange and anthocyanins are the pigment of colors that distribute in blue to violet pigments. Meanwhile, synthetic colorant is manmade colorants that are made in a laboratory. Synthetic colorants made in a controlled atmosphere without any impurities which makes it dominate the manufacturing industries. In this study, these two types of colorant can be extracted from its material by undergo certain process such as extraction process (Epp and Sarguis, 2000).

A major problem with colorants is that they tend to fade when being exposed. Stabilizer is functioned to maintain the quality of the colorants that are placed in any types of environment. There are many types of stabilizers used in the

industries in order to maintain the color's stability. One of the most effective stabilizers called maltodextrin. Maltodextrin can be classified as a sweet polysaccharide or can be described as sugar contained by hydrolysis of natural corn or starches. This stabilizers came in as powder that contains little amount of fiber, fat and protein (Santostrading.com.au).

Spectrophotometer is an absorbance spectroscopy that is able to measure the amount of light at a specific wavelength that passes through a medium. This instrument can be classified into two types. A single-beam spectrophotometer which is the simplest spectrophotometer and it was minimized by using double-beam spectrophotometer. Spectrophotometer can be used in many methods as CIE lab is one of the best method. CIE lab method is functioned to give precise definition of the color of a test sample. This method based on light, object and detector. CIE lab is able to describe the pigment concentrations by using its calorimetric scale and light or observer conditions (Gonnet, 2001). The CIE lab method will determine the properties of the certain amount of colors and measure its color stability of a certain sample.

Color stability is defined as the ability of a certain light source to maintain its color properties especially in its appearances over time. The stability of color for each source is majorly different. The colors development of a certain products will differ in a certain degrees according to its properties. In this study, blue pea flowers will be used as the sample. This flowers also known as *Clitoria Ternatia* which a fast tropical climber plant in tropical collimates, especially in Asian countries. The flowers have the vivid deep blue color that shows its most striking features. It is believed to have been brought to India in the 17^{th} century (Vargas and Lopez, 2003). The colors are widely used in colorant industries such as for food and dyes. There are many uses of this flower's color in around the world. Each tradition uses it in their specific ways.

1.2 Problem Statements

Colors are vey important aspect that can highly give influences to consumers which they can be tempted to buy a good quality of colored products. Colors can be one of the factors of marketing technique to the manufacturers as it is widely used in the industries such as on foods, cosmetics, coloring and dying process. Some colored products may change in color due to outdoor exposure. This is mostly because of the color properties in the product itself that interact with the surrounding. Some qualities of colors are poor and this gives a lot of effects to consumers and also to manufacturers, in health and economics. The colors need to be maintained in a good condition so that its quality can be assured as it will gives satisfaction to consumers. Other than that, some of colored products might give harm to consumers. As for the products that have been colored synthetically, it may contain unwanted chemicals that can affect the consumers, specifically in health. Thus, in order to have a better controlled in its quality, measurement and appearance, color stability need to be observed and improved on natural colorant.

1.3 Objectives

The purpose of this study is to determine the color stability of Blue Pea flowers by using CIE lab method based on storage days and the use of different solvents and concentrations.

1.4 Scope of Research

Several scopes have been identified in order to achieve the objective of this study, which are:

i. Blue Pea flowers.
ii. Analysis of colors using CIE Lab method.
iii. Pigments of colors that contributes to the color of Blue Pea flowers.
iv. Effect of the concentration and solvents difference based on storage days.
v. Difference in color properties based on the storage days.

1.5 Rationale and Significance

There are some rationales and significances in determining the color stability of natural colorants. In order to ensure the quality of the desired colors a natural colorant should be used in the industries. Since the demand of natural colorants is much higher than synthetic colorants, the usage of these colorants is used widely. Therefore, certain aspects need to be taken in order to maintain the safety of its usage and gives the satisfaction to the consumers.

CHAPTER 2

LITERATURE REVIEW

2.1 Colorant

Colorant comes from the name of color which does not exist by itself but it depending on the source of light. Color can be categorized into two stages. First, it consists of pure physical phenomenon which required three elements – source of light, an object and detector. Second, incompletely known process occurs where the eye receptors transmit the information that the brain will interpret as color. All colors perceived by the human eye are associated with the light radiation in specified range of values as shown in Table 2.1. As for light, it has different wavelengths radiation. Visible light where its wavelength is between 380-750 mm, are very important to color appreciation (Vargas and Lopez, 2003).

Table 2.1: Light radiation of colors in specified range of values perceived by the human eye (Vargas and Lopez, 2003).

Colors	**Wavelengths radiation, λ (mm)**
Violet-blue	$380 < \lambda < 480$
Green	$480 < \lambda < 560$
Yellow	$560 < \lambda < 590$
Orange	$590 < \lambda < 630$
Red	$630 < \lambda < 750$

Color is often the first notable characteristic of a food and it influences the expectations of consumers buying the product and also influences food handlers or manufacturers who make quality-related decisions. More specifically, color predetermines our expectations and perceptions of flavor and taste. Color is often used as an indicator of food quality due to short evaluation times and cost savings (Vargas and Lopez, 2003).

2.1.1 Food Colorant

Food colorant means any substance which restored the color in a foodstuff or any product that requires coloring, which contains natural component. Food coloring is used both in commercial food production and in domestic cooking. They are tested for safety by various bodies around the world and sometimes different bodies have different views on food color safety. Food colorant can be classified into two which are natural colorant and synthetic colorant (Socaciu, 2008).

2.1.2 Natural Colorant

Natural colorant can be defined as colors that appear in fruits, vegetables or flowers due to the chemicals that occurs naturally. There are several types of natural colorant pigments.

First are chlorophylls. They are the green pigments of leafy vegetables. They also give green color to the skin of apples and other fruits. In the second are carotenoids which contribute to the red, yellow, and orange colors in many fruits and vegetables. This group of compounds includes carotenes, which are strictly hydrocarbons. Third are the anthocyanins. They are responsible for the blue, pink,

red, and violet colors in fruits and vegetables. This group of natural colorants is sensitive to pH, but is fairly heat stable and resists fading in daylight. This group is playing an increasingly larger colorant role for various foods (Epp and Sarguis, 2000).

2.1.3 Synthetic Colorant

Synthetic colorant is color that is scientifically made by human being. Most consumers find a colorless food unappealing, which is why colorants are added. Some foods are colored synthetically because they have no color or their natural color has been altered or faded during processing or storage. Currently, seven synthetic colorants are approved by the government for use in food. Table 2.2 below shows approved colors to be used in colorant industries with its functional group.

Table 2.2: Colors and its functional group (Epp and Sarguis, 2000)

Color	**Functional group**
2 Reds	#3 and #4
2 Blues	#1 and #2
2 Yellows	#5 and #6
1 Green	#3

These seven colorants are grouped by the color-giving chemical functional group they contain. Just as with any substance, the chemical structure of each these colorants determine its' characteristics, for example if it is water soluble or not. Water-soluble colorants are useful in water-based foods, but not in fatty foods such as salad dressings and ice cream. Therefore a special form of colorant is prepared by attaching the water soluble colorant to an insoluble material (Epp and Sarguis, 2000)

2.2 Spectrophotometer

Spectrophotometer is an instrument that functioned to measure the amount of light of a specified wavelength which passes through a medium. According to Beer's Law, the amount of light absorbed by a medium is proportional to the concentration of the absorbing material or solute present. Thus, the concentration of a colored solute in a solution may be determined in the lab by measuring the absorbency of light at a given wavelength. Wavelength or lambda is measured in nm. The spectrophotometer allows selection of a wavelength pass through the solution. Usually, the wavelength that has been chosen corresponds to the absorption maximum of the solute. Absorbency is indicated with a capital A (Christian, 1986).

Christian (1986) works also tells that spectrophotometer can be classified into two types which are single-beam spectrophotometer and double-beam spectrophotometer. In a single-beam spectrophotometer, there is a single beam from the light source. The general configuration of a single beam spectrophotometer is shown in Figure 2.1. The reference standard is measured to standardize the instrument, and then removed. For the single beam configuration to perform well, the light source, detector and electronics must be reasonably stable over time.

As in double beam spectrophotometer, the beam from the light source is split into two. Figure 2.2 shows the general configuration of a double beam spectrophotometer. One beam illuminates the reference standard and the other illuminates the sample. The beam may be combined before they reached the monochromator. The splitting of the beam is normally accomplished in one of two manners which are statically with a partially-transmitting mirror or similar device; or by attenuating the beams using moving optical and mechanical devices. Double beam instruments become popular in the early days of spectrophotometry due to its instability of light sources, detectors and the associated electronics (Christian, 1986).

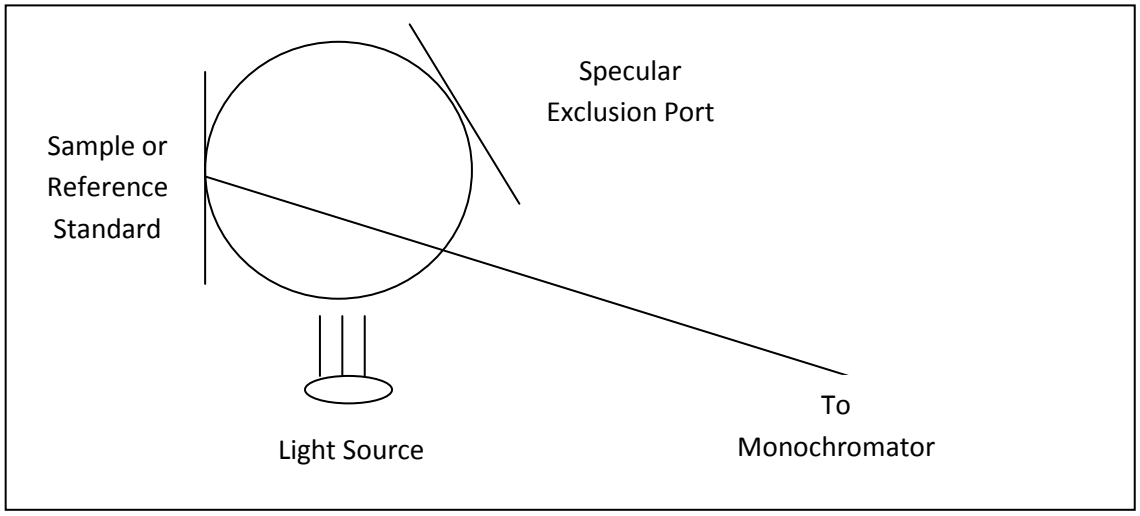

Figure 2.1: General configuration of a single beam spectrophotometer (Christian, 1986).

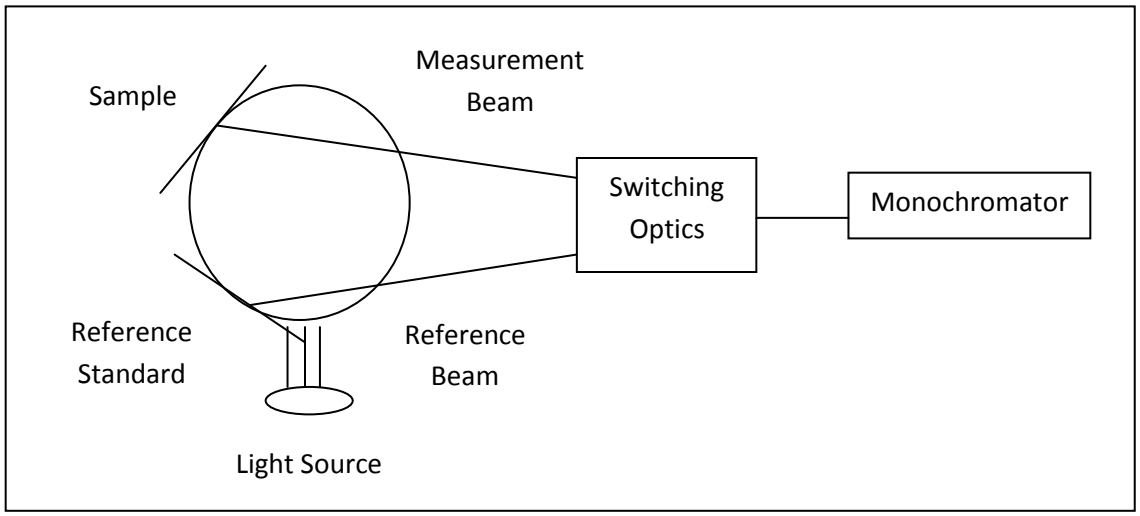

Figure 2.2: General configuration of a double beam spectrophotometer (Christian, 1986).

2.3 Color Stability

Color stability can be defined as the ability of any light source to maintain its color and appearance properties over its life. The main purpose of color stability is actually to obtain an appealing product color. Colors will interact with other components to achieve its stability and by that, it is very important to know the interactions between them. Temperature can be one of the parameters that can give influences to the color stability. Also, its shade and the process recommended to attain its final quality, packaging and shelf life requirements are important too (Vargas and Lopez, 2003).

2.3.1 CIE Lab

In 1986, the classical method was established by the "Commission Internationale de L'Eclairage'' (CIE) where it was based on the determination of tristimulus values which means the magnitudes of three standard stimuli needed to match a given sample of light, on which is based three-dimensional space called the CIE-xy space. But, this commission has adopted a new color space called the CIELAB space, as a better measurement of color (Magarino and Sanjose, 2003). This three-dimensional color space is a non-linear transformation of the CIE XYZ tristimulus values and each colour is defined by its coordinates as shown in Table 2.3.

Table 2.3: Coordinates used in CIE lab method with its appearances of colors (Magarino and Sanjose, 2003).

Coordinates	**Colors /Appearances**
L*	Lightness
a*	Green - Red
b*	Blue - Yellow
C*	Metric Chroma
h	Hue Angle
E*	Color Change

These parameters are calculated by using the CIELAB calculations formula shown on the Equations 2.1-2.6 below (Senthilkumar, 2007).

$$L* = 116(Y/Y_n)^{\frac{1}{3}} - 16 \quad (2.1)$$

$$a* = 500\left[(X/X_n)^{\frac{1}{3}} - (Y/Y_n)^{\frac{1}{3}}\right] \quad (2.2)$$

$$b* = 200\left[(Y/Y_n)^{\frac{1}{3}} - (Z/Z_n)^{\frac{1}{3}}\right] \quad (2.3)$$

$$C*_{ab} = (a^2 + b^2)^{\frac{1}{2}} \quad (2.4)$$

$$h° = \tan^{-1}(b^*/a^*) \quad (2.5)$$

$$\Delta E^*_{ab} = \left(\Delta L^{*2} + \Delta a^{*2} + \Delta b^{*2}\right)^{\frac{1}{2}} \quad (2.6)$$

This system is based on the three elements that are involved in color evaluation which are source of light, object and detector. The main objective of the CIE lab system is to obtain the calorimetric results that valid for normal people with the normal vision (Vargas and Lopez, 2003). Furthermore, this method is the most precise to measure the color and the most useful in the characterization and

differentiation of color. Therefore, CIE method provides a more precise definition of color than the other methods, since CIE method uses measurements over the complete visible spectrum, similar to the one perceived by the human eye. Figure 2.3 shows the framework of CIE Lab Color Model. The coordinates will be able to show which color for a certain samples are in depending on the calculations made by using the equation mentioned above.

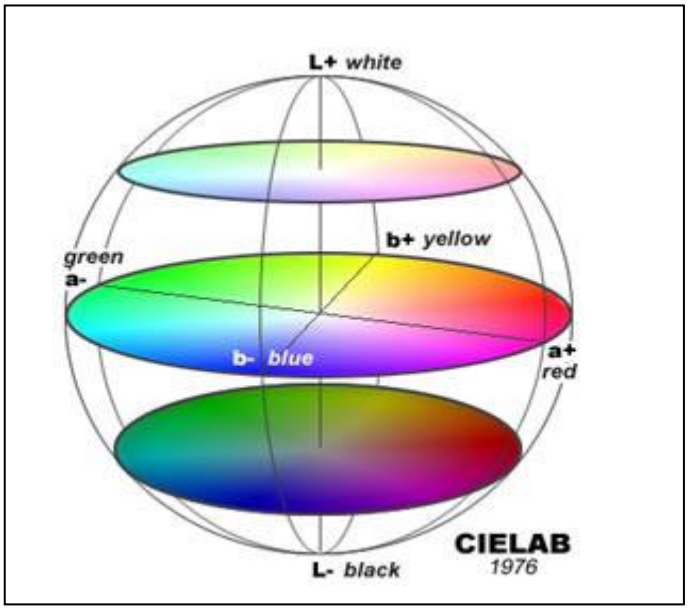

Figure 2.3: Framework of CIELAB Color Model (Personales.upv.es).

2.3.2 Stabilizer

Color is easily faded when exposed to sunlight or any other electromagnetic radiation. It is believed that most of the fading colorants when exposed to the light are due to oxidation or reduction of the colorants upon the environmental conditions in which the colorants is placed (Nohr *et al*., 1999).

Stabilizer is functioned to maintain the quality of the colorants that are placed in any types of environment. There are various factors that affect the fading

of the colorants, which are temperature, humidity, gaseous reactants (including O_2, O_3, SO_2 and NO_2), water soluble and nonvolatile photodegradation products. Nohr *et al.* (1999) have studied that generally, the most unstable colorants will be more faded efficiently by visible light while those of higher lightfastness were degraded mainly by ultraviolet light. The influence of stabilizer can be extremely important.

2.3.2.1 Maltodextrin

Maltodextrin can be described as sugar obtained by hydrolysis of natural corn or rice starches that are easily digestible. As shown in Figure 2.4, maltodextrin is classified as a sweet polysaccharide. It is one of the colorant stabilizers that are able to extend the life of the colors appearances and also can be used as flavor enhancer in candies and chocolate. Maltodextrin is a convenient source of energy that contained approximately only 4 calories per gram. It supplies carbohydrate for nutritional beverages. While containing sweet qualities, maltodextrin is considered to contain fewer calories than sugar (Santostrading.com.au).

In producing maltodextrin, natural enzymes and acids help to break down the starch even further. The end result is a simple white powder that contains extremely small amounts of fiber, fat and protein. Most of maltodextrin can be considered as inorganic since it is not produced by organic farming methods but they are produced on conventional farms (Santostrading.com.au).

Figure 2.4: Maltodextrin Stabilizer

2.4 Blue Pea Flowers

The Blue Pea flowers also called as Butterfly Pea or Pigeon Wings flowers is a fast tropical climber plant in tropical collimates which bring it as a native to Asian tropical. Although it can be found growing in our region, the Blue Pea has been introducing to Africa, Australia and some other countries. This flower grows as vine or creeper that blooms in only 6 weeks from seed and it bloom all year long. It needs intermediate temperatures, but it can be suited in our hot Asia temperatures (Jain *et al.*,2003).

Figure 2.5: Blue Pea Flower (Wikipedia, 2010)

2.4.1 Description

The Blue Pea is also known as *Clitoria Ternatea Linn.* as its scientific name is a perennial herbaceous plant. Its leaves with 4cm long by 3cm wide are elliptic and obtuse that can easily gives its pretty blue color as shown in Figure 2.5. The leaves pinnated into 5 to 9 leaflets and it often grow into thick foliage. Its flat pods contain 6 to 10 seeds in each pod which will pop black seeds when mature. The pods are 5-10 cm long, straight and sharply beaked (Mukherjee *et al*., 2008). The seeds are yellowish-brown or blackish in color and oval in shape. The flowers last for only 24 hours as it is very soft and tender. It requires little care when cultivated. The most striking feature of this flower is its vivid deep blue colors with light yellow markings, solitarily.